Space Weather Technical Forecast

Issued on Thursday, 06 October 2022 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor storms possible throughout. Ongoing likelihood of M-class flares with slight chance of isolated X-class flares.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low, with only C-class background flares in the last 24 hours. AR3110 has been the most active region, but the majority of this has now rotated across the limb. AR3112 continues to be the largest region on the visible disc, by remains inactive, with some evidence of simplification in the spot arrangement, although the magnetic structure is still complex. The remaining five regions are all relatively simple and inactive. A CME which left the southwest on 05 October has been analysed in the last 24 hours, with modelling suggesting that this will clearly miss the Earth.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed by DSCOVR at L1 averaged between 500-550km/s until 05/1900UTC, but have recently declined to around 450km/s. Density has been around average. Total interplanetary magnetic field strength, IMF, was weak for much of the period, but spiked to moderate levels at 05/1610UTC, reaching a peak of 9nT, but has steadily declined back to weak levels. The north-south component, Bz, has varied weakly throughout, but with a sharp negative peak of 7nT around 06/1627UTC. These observations are indicative of the passage of a transient CME through the high speed stream. Phi angle has been predominantly positive (away from the Sun). Resultant geomagnetic activity was Quiet to Active.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at background levels. High energy electron flux (greater than 2 MeV) increased from moderate to high levels, peaking at 2.63e3 pfu, before returning to moderate levels. Electron fluence followed an increasing trend, reaching 4.97e7 integrated pfu by 05/2100UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be mainly Low, with occasional Moderate activity and a slight chance of High activity.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 04 October is forecast to arrive at Earth late on 06 October, with low confidence due to limited imagery available for analysis. Otherwise the high speed stream from coronal hole 30 is forecast to decline during 06 and 07 October. A further high speed stream from coronal hole 29 is then expected to connect with the Earth on 08 October. Geomagnetic activity is expected to start Quiet to Unsettled with isolated Active intervals. G1/Minor Storms are then possible from late on 06 and through 07 October, with activity perhaps easing later. A further risk of G1/Minor storms on 08 October due to the onset of the next high speed stream.

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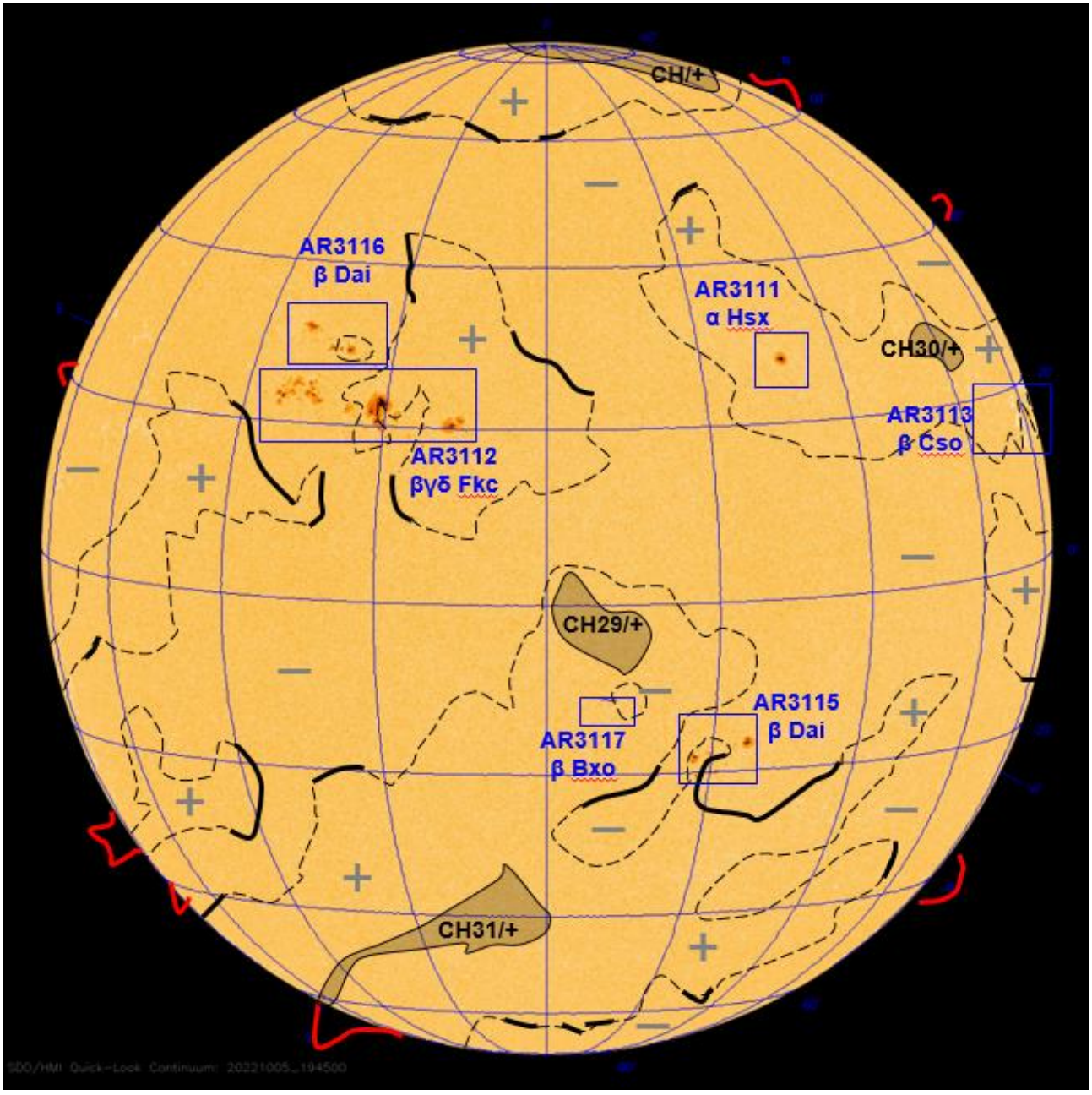
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near background for much of the period, but with a slight risk of minor proton storms, most likely due to AR3112. Electron flux is expected to oscillate between moderate and high levels. Electron fluence is likely to continue to rise and exceed the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 05/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 03 October appears to have glanced the Earth late on 05 October. Two further CMEs left the Sun on 04 October, with one from the southeast quadrant forecast to arrive at Earth late on 06 October. Although much of the feature is expected to move to the south of the Earth, the northernmost portion is likely to affect the Earth. A filament eruption which left the Sun on 05 October is forecast to miss the Earth.

The Earth is otherwise under the waning influence of a high speed stream, with the main contribution from coronal hole 30 in the northwest quadrant. This is expected to continue to wane towards background levels on 06 October, although any decline is likely to be fitful due to the potential effects of a CME arrival. The high speed stream from coronal hole 29 is then forecast to affect the Earth on 08 and 09 October.

Quiet to Unsettled with isolated Active intervals are forecast on 06 October for much of the day, but with a risk of G1/Minor Storm intervals later due to the potential CME arrival. Similar for 07 October due to residual effects of the forecast CME. The onset of the next coronal hole high speed stream on 08 October could then give a risk of further G1/Minor Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	20	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1734	Partial	Filament	SE quadrant	980 km/s	06/2100UTC	Low confidence

Figure 2: MOSWOC Enlil model at the time of estimated shock arrival.

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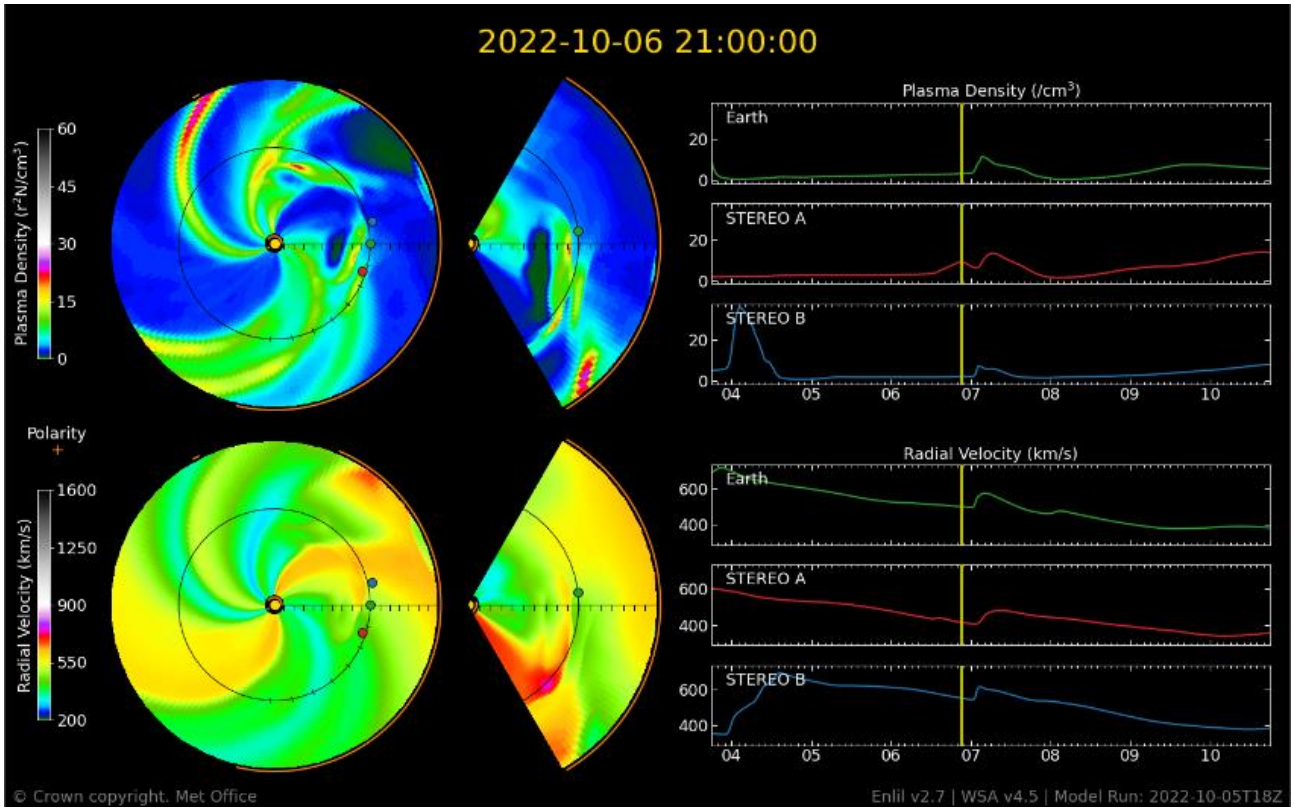

Figure 3: MOSWOC Enlil ensemble. The trend has been for the spread of solutions to move forward in time. However as Enlil is currently around 100 km/s to fast with the solar wind speeds, a later solution is favoured.

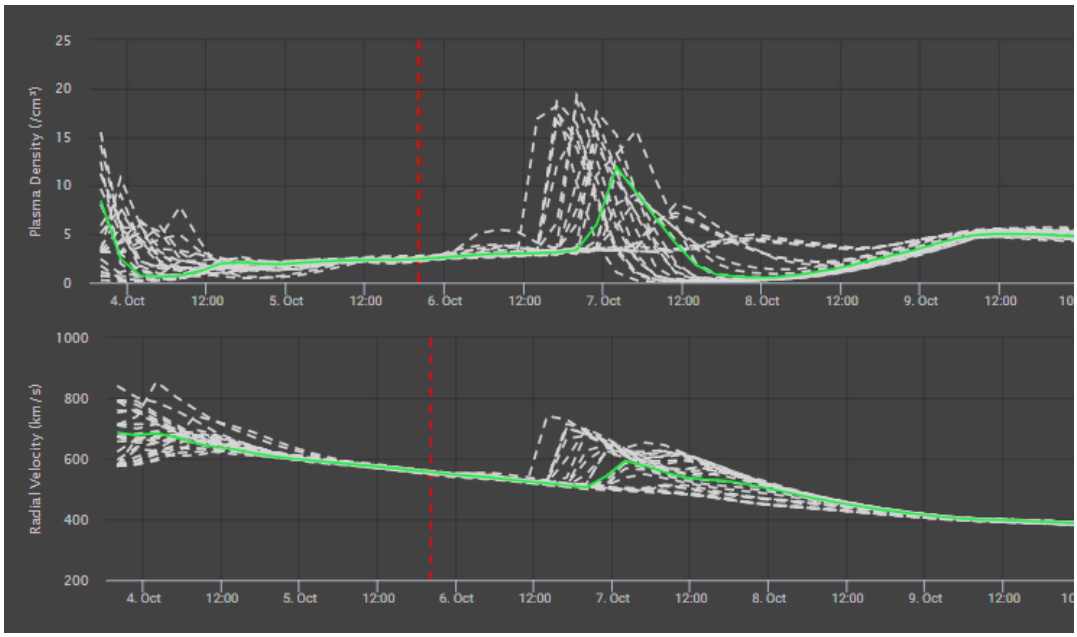

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Figure 4: Recent observations at L1, with the CME transit clearly discernible at the end of the period.

Radio Blackouts - X-Ray Flares:

Solar activity is at Low levels with only background C-class activity on the last 24 hours. The most recently active region, AR3110 is slowly rotating across the western limb, but will continue to present a diminishing risk of high energy flares and proton storming from just across the limb. The large region AR3112, is the most complex region on the disc and despite recent apparent simplifications in the spot arrangement, the region remains magnetically complex and continues to present a risk of both significant flares and proton storms. Classification of the remaining regions suggests limited risk of flare activity.

Low, activity is expected with occasional Moderate flares and a slight chance of X-class flare activity.

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X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	50	50	50
Very Active	R3 to R5 X Class	No	15	15	5	5

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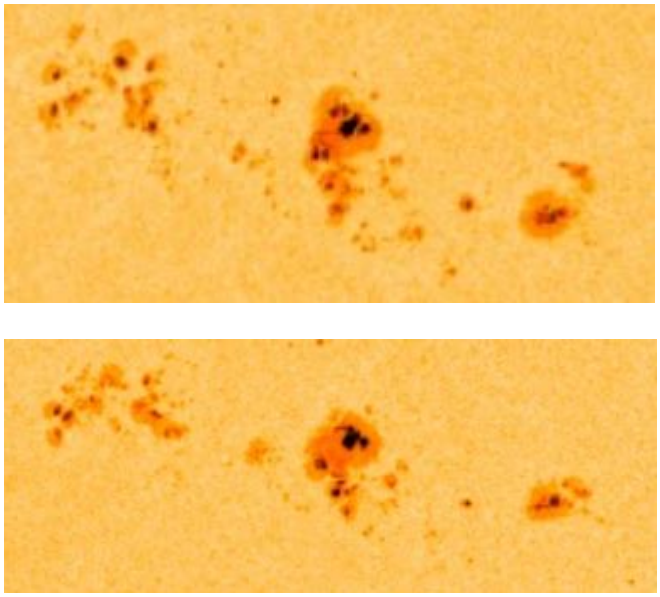
Figure 5: SDO HMI intensity comparison of AR3112 from 24 hours ago (top) and recently (bottom). Some merging of spots can be seen, suggesting a simplifying trend.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is at background levels. There is a slight chance of exceeding the S1 threshold, primarily from any further M or X-flares from AR3110 (which is rotating around the west limb), but potentially also from AR3112 in the northeast given any sufficiently strong flare event.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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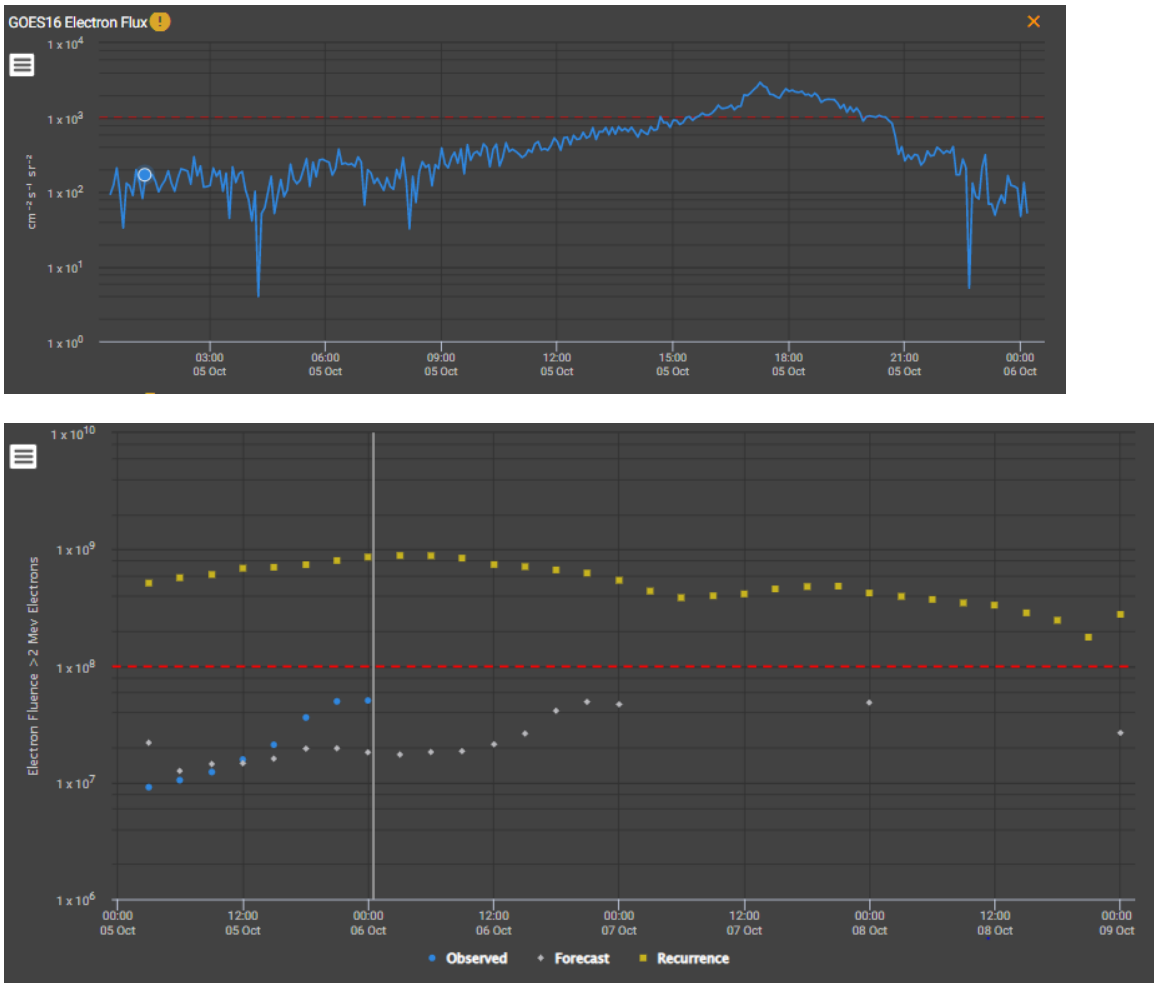
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) has reached high (1e3 pfu) levels in the last 24 hours and is expected to continue to oscillate between moderate and high levels through the next four days, with brief dips in periods of enhanced geomagnetic activity.
Electron fluence levels are expected to follow a rise towards the Active (1e8 integrated pfu) threshold, based on the heightened flux environment.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	60	70	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	5

Figure 6: GOES 16 electron flux (top) and MOSWOC REFM model (bottom) reflecting the trend in increasing electron counts.



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